

we had seven wild crocodiles swimming toward us in response to a mimic distress cry when a medium sized mugger suddenly burst out of the bushes on the bank behind us and charged right past us, open mouthed. In the Gir at Hiran Lake, with Sanat Chavan, Park Warden we had a 3 metre mugger come out almost to our feet, again in response to the mimic juvenile distress cry. It only returned to the water when we tapped with a walking stick in front of its snout. In our experience mugger learn about this deception quickly and it would rarely work twice in the same place and sometimes not at all. It was especially dramatic in a new, fairly undisturbed population. In Sri Lanka last year, in the company of a Lanka herpetologist, R. Senanayake, we watched no less than 16

crocodiles approach us. Being in a low unprotected spot we hastily quit the area.

We have never heard mugger bellow as do alligators. Sometimes during threat displays (and mating) one or both participants will emit gargling growls, the inferior one (with upraised head in appeasement) usually ending in a typical crocodile grunt. The loudest sound we heard from a mugger was a wild caught female of just under 2 metres, caught in a net. Brought to shore and caught by the tail the crocodile emitted loud, deep distress cries with a tone similar to a calf's voice. The most typical mugger sounds are the grunts which the juveniles start using while still in the egg to communicate to the parent (and other eggs) their readiness to hatch.

MADRAS CROCODILE BANK,  
MADRAS,  
June 5, 1977.

R. WHITAKER  
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# 15. NOTES ON CAPTIVE BREEDING IN MUGGER (*CROCODYLUS PALUSTRIS*)

The 600 ft circumference breeding pond for mugger at the Madras Crocodile Bank holds approximately equal land and water area. The pond was dug to the water table and banks for basking were created with excavated sand. Clumps of pandanus and *Casuarina* and when necessary temporary palm leaf shelters provide shade. As far as possible, wild conditions have been simulated. In the rains the maximum water depth is 3 m and in the summer 1 m. Maximum and minimum air temperatures during the incubation period are 42°C and 28°C.

The enclosure supports 14 mugger; 8 females (3 adults) and 6 males (2 adults). Under normal circumstances this is a fairly compatible group and little serious fighting occurs.

1977 was the second successful breeding

year and notes on nests and nesting behaviour are given below.

## *Nests and hatching:*

Both at the Crocodile Bank and at the Snake Park (one pair of adults) mating commenced from mid January.

On the night of 20th February the 13 year old female at the Snake Park laid 10 eggs in her nest 20 cm under the (laterite) soil. The eggs were transferred to hatching boxes on 15th April, and 6 hatched on 16th May.

On the night of 3rd March a 15 year old female ("Alpha") at the Crocodile Bank breeding pond laid 28 eggs under 26 cm of sand in a *Casuarina* clump in the north-west corner of the enclosure. Sand had been thrown

off to first create a body pit to prevent the nest from filling up. Alpha entered the water at 7 a.m. the following morning closely attended by Beta, her mate (largest male) and Mett (second largest male). Mucous still hung from her cloaca and she seemed greatly fatigued, making only half hearted and feeble attempts to charge while the nest was being examined. The 28 eggs were transferred to hatching boxes on 28th April, and all hatched on 6th May.

On the night of 21st March a 7 year old female in her second laying year deposited 24 eggs, slightly to the north of Alpha's nest. The eggs were collected in hatching boxes on 9th May and only 3 hatched on 25 May.

A third undetected nest of 10 eggs was laid on the south bank by a first year layer. On 25th April an open nest hole was seen with 3 empty egg shells and 7 intact eggs. One juvenile was spotted in the pond and netted after considerable difficulty; during this exercise Mett and Alpha repeatedly charged us as we moved along the south bank. The juvenile, before it was noosed, swam slowly around Mett's jaws. There was no sign of the other two juveniles who were probably eaten, by a sub-adult. On 27th April the remaining 7 eggs were opened after candling and only one contained visible remains of a very young embryo. The eggs were not dessicated; they were either infertile or the embryos had died early from an unknown cause.

#### *Mating behaviour:*

Morning, evening and occasional nocturnal observations were made on Alpha (biggest female), Beta (biggest male) and Mett (second-largest male), during March.

Beta and Mett are the dominant males of this group. During the breeding season (January to June), they were constantly bullying sub-adult males, chasing them around the en-

closure and biting them on the tail and back. Mett was very much second in command however and would often make submissive gestures (raising head to show underside of jaw) when basking or swimming near Beta.

Alpha and Beta commenced mating in mid January and mated regularly while Alpha was incubating her eggs. To give an idea of mating frequency, from 5th to 11th March mating was observed every day except one, in the morning (8 a.m. to 11 a.m.) or late evening (5.30-6 p.m.). Copulation lasted from 7 to 10 minutes.

After Alpha had nested, mating always occurred in the western end of the tank, below the nest. Prior to mounting, the male often bites water with a loud side-ways clap and hisses, sometimes swimming to the female with his back out of water but more often reaching her under water. Often Beta would grunt nasally before submerging; this display however could also be a threat (to other males) and not exclusively mating behaviour.

The following extract from our notes of 6th March describes the mating procedure. 8.05 a.m.—Alpha slides into water from nest, Beta on north bank. Beta swims, back slightly out of water, to Alpha rests with nose touching her tail. Alpha turns around, swims to west; Beta makes long, loud nasal grunt, follows, and mounts. Alpha submerges, Beta half submerged. Mett swims up from east of tank, circles mating pair, stops with head parallel to Beta's, rests head on Beta's back, after short submissive gesture. Mett submerges as Alpha and Beta submerge further. Alpha and Beta surface after ten minutes, still mating. Beta hisses, submerges again and surfaces, hissing. Beta rolls over and dismounts.

On two occasions Alpha was seen making what appeared to be a mating display, both times when Beta was at some distance and had not mated with her that day. She would roll

on her back, remain this for a few seconds, and roll over again. Her cloaca seemed slightly extruded and what were possibly the scent (musk) glands were momentarily visible.

Although Mett did not mate with Alpha (Alpha mated only with Beta) he enjoyed a special status. Alpha was intolerant of other crocodiles in the proximity of her nest or in the corner of the tank below the nest, and Beta consistently chased out other males from the area, but Mett was tolerated by both and was allowed close proximity even while mating was going on. He was frequently to be seen basking not 6 ft. from Alpha's nest.

Beta also mated with another female while Alpha's eggs were being incubated. Prior to mating she was observed rubbing the underside of her jaw on his head, swimming around him in circles and once, when Beta ignored her advances, she blew out a terrific mass of water bubbles into the air.

Mating continued at least upto 4th June, when Beta grunted nasally before mounting Alpha. When Mett came over however Beta left Alpha, mounted Mett, and adopted the mating posture!

#### *Temperatures and egg sizes:*

##### TEMPERATURE RECORD FOR NEST 4 (SNAKE PARK)

(10 eggs—size range  $7.2 \times 3.8\text{-}8 \times 4$  mm. Average  $7.5 \times 4$  mm)

Date	Surface			Egg Level		
	Morn.	Aft.	Eve.	Morn.	Aft.	Eve.
16/3	28	29	30	28.5	33	31
19/3	28	32	31	29	30	29
23/3	28.5	29	30	29	30	29
30/3	30	33	31	28	29	30
2/4	30	33	30	29	30	29
6/4	30	31	30	29.5	30	29.5
9/4	34.5	33	33	29.5	31.5	31.5
13/4	31	32	31	30	31	30

16/4	31	31.5	30	30	30	29.5
20/4	30	31	30	29	30	29
23/4	31	34	33	30	32	31

#### *Protection of the nest:*

Individual females vary considerably in nest protection. Shortly after laying her eggs, Alpha sustained an injury on her right hind foot which rendered the ascent to the nest a painful exercise. During this period she would not attempt coming up when nest temperatures were being taken, but toward the end of the incubation period when the leg was healed she would rush out of the water to the nest on sensing the slightest disturbance near it. She would usually charge open mouthed and belly flop on the nest. Crocodiles basking on the western bank near the nest were frequently chased and bitten. Alpha's daily routine was: Coming to the water (8 ft. below nest) at 7.30-8 a.m. and unless there was disturbance near the nest, returning to it only at 6-6.30 p.m. Nights were spent on the nest. Incubation and protection continued after the eggs were collected. On 10th May she chased a sub adult male basking near the nest halfway round the enclosure and bit him on the back and tail, while he repeatedly made submissive gestures. As late as 7th June, a month after the eggs had hatched, she chased RW an assistant out of the enclosure.

The other two nests did not enjoy such dedicated protection and the females were never observed chasing intruders. The nest to the north of Alphas' was often exceedingly wet in the mornings and the theory that a broody female urinates or evacuates water on her nest comes to mind. A wild mugger nest in Kedarhalla in 1975 had the same degree of wetness and Reuben David reports cloacal nest wetting at Ahmedabad Zoo.

Alpha did not feed during the entire incubation period, although rats, fish and frogs were



offered to her and there was always plenty of food in the tank. She was first seen to catch fish in the tank on 3rd May. About this time also, she started leaving the west end of the tank and venturing out into the open water expanse, with the other crocodiles.

The 13 year old female mugger at the Snake Park which laid on 20 February guarded her nest from a pool in the west corner of the enclosure. She made serious charges at intruders, followed by a furious chase which brought the man to the other side of the wall. (Alpha had been more inclined to reach her nest only, and belly flop on it). It is a matter for conjecture whether the intruder would be bitten if caught up with. W. T. Neill (LAST OF THE RULING REPTILES) doubts that the American Alligator bites in similar circumstances and there are no records of mugger actually biting in nest defence. However in Orissa there are two authentic records of gharial having done this.

After half the incubation period was over the

MADRAS CROCODILE BANK,  
MADRAS,  
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Snake Park female suddenly directed her protective instincts to the southern corner of the enclosure, charging at any disturbance there and allowing the actual nest to be approached with impunity. As late as 20 May she rushed out open mouthed when this area was approached. This disorientation was perhaps caused by our forceful prevention of her access to the nest while humidity and temperature checks were being taken.

Male mugger have not thus far been reported to participate in nest protection. On two occasions during incubation, Beta was seen to stay in the water below the nest when Alpha took a short turn in the open tank. However this might be pure coincidence. But Mett's repeated lunges and attacks while the juvenile was being caught, and the male mugger's active response to the distress cry of the young are significant and indicate perhaps a higher degree of protective interest than we believe.

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# 16. GROWTH RATE OF *CROCODYLUS PALUSTRIS*

From June 1975, 71 hatchlings from wild collected and captive bred marsh crocodile nests were reared at the Madras Crocodile Bank. For the first three months they received live tadpoles, live small fish and chopped fish. The living tadpoles and fish were added to the rearing ponds to maintain a density suitable for easy capture. The finely chopped fish was put on large leaves at night to ensure that even hatchlings unsuccessful at catching live prey would feed. In addition a sixty watt light bulb was kept in the hatchling enclosures to attract

insects at night. As seems to be true of most animal groups reared together, a few grow exceptionally rapidly, a few extremely slowly and the majority at an average rate (see table).

At the time of writing these crocodiles are two years old and up to 1.7 metres in length or a growth rate of up to 6 cm. per month. One often sees captive reared crocodiles in a very stunted condition; in fact many people who should know better maintain that crocodiles only grow 30 cm a year. Given the right diet, sufficient cover and sunlight in a spacious